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551.521.11(415)METEOROLOGICAL OFFICECLIMATOLOGICAL MEMORANDUM No. 36CALCULATION OF AVERAGE SUNSHINE VALUES FOR IRELANDby P.G. Rackliff
(Meteorological Office, Belfast)Data & Method

L.P. Smith¹ has produced formulae for average sunshine values in England and Wales, using distances from the nearest coast and from the south coast, as the basis for his calculations. These calculations, after applying a correction for height, gave values in close agreement with actual average values for any place which was unobstructed and unaffected by smoke pollution. Similar methods have been tried for Ireland, with encouraging results, although the constants were derived algebraically by substitution, without recourse to multiple regression analysis.

Basic values used were annual averages of daily mean duration of bright sunshine. These averages were available for 18 stations within the Republic, and a further six stations in Northern Ireland, making a total of 24. The stations are listed below as Table 1. This is a rather coarse network, with the exception of the Dublin area, and there are no mountain recorders; furthermore, it is only recently that records have become available for the county of Wexford, the sunniest county in Ireland. Average values for Wexford are given at the foot of Table 1.

Table 1 shows that 30-year averages are only available for nine stations. All other averages have been weighted to the standard period 1921-1950, but only stations with records extending over 5 years or more are included. The average sunshine map for this period is shown as Figure 1. The drawing is rather subjective and it should be noted that some allowances have been made for the probable effects of mountains, as discussed in the latter half of this note. It is evident that average south-coast values are well exceeded in Wexford, and it was not possible therefore to follow Smith's procedure of using distance from south coast as a basic parameter. It was decided, following the trend of the isohels, to measure instead from a base line passing through points of easy reference in the south-east of the country, namely the towns of Wicklow and Waterford (henceforth referred to as the W - W line), and to exclude county Wexford, where the isohels indicate a marked increase in the rate of change of sunshine duration, towards Rosslare.

Calculations

The mean of the average values for the two stations Tycor (Waterford) and Newcastle (Wicklow), namely 4.13 hours/day, was taken as the base value (BV) for the W - W line. Distance from the nearest coast (Mc) and from the W - W line (Lw), measured in tens of miles, was tabulated for all stations. Stations situated less than 10 miles from the nearest coast were treated as coastal sites, and a correction factor



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TABLE 1 - Stations used for average sunshine calculations for Ireland

County	Station	Plotting No. (see Fig.2)	Annual Average, 1921-50 (mean hours per day)
Antrim	Aldergrove	1	3.53 *
Armagh	Armagh Obsy.	2	3.46
Armagh	Bessbrook	3	3.71 *
Clare	Shannon Airport	4	3.86 *
Cork	Ballincurra	5	3.80
Cork	Univ.College,Cork	6	3.86 *
Donegal	Malin Head	7	3.55 ^{S1}
Down	Hillsborough	8	3.57 *
Dublin	Dublin Airport	9	4.06 *
Dublin	Baldonnell	10	3.73 *S
Dublin	Phoenix Park	11	3.80
Dublin	Rathfarnham	12	4.06 *
Dublin	Howth	13	4.15 *
Fermanagh	Castle Archdale	14	3.53 *
Kerry	Valential Obsy.	15	3.67 S
Londonderry	Ballykelly	16	3.64 *
Mayo	Claremorris	17	3.50 *
Mayo	Mallaranny	18	3.46
Offaly	Birr	19	3.47 ²
Sligo	Markree Castle	20	3.30 S
Waterford	Seskin	21	3.91
Waterford	Tycor	22	4.13 *
Westmeath	Mullingar	23	3.52 *
Wicklow	Newcastle San.	24	4.12 *
Stations not used			
Wexford	Johnstown Castle	-	4.21 *S
Wexford	Rosslare	-	4.85 *

* Adjusted average, weighted to the period 1921-1950 (from overlapping records: minimum duration 5 years)

¹ Recorder raised from 71 ft. to 93 ft. above M.S.L. and moved about 70 ft. eastwards, in October 1929.

² Station moved from Birr Castle to John's Mall, one mile S.S.E., in October, 1939.

S Slight attenuation of the record due to obstacles above the horizon for more than 5% of the time during which the angular altitude of the sun above the horizon was 3° or more.

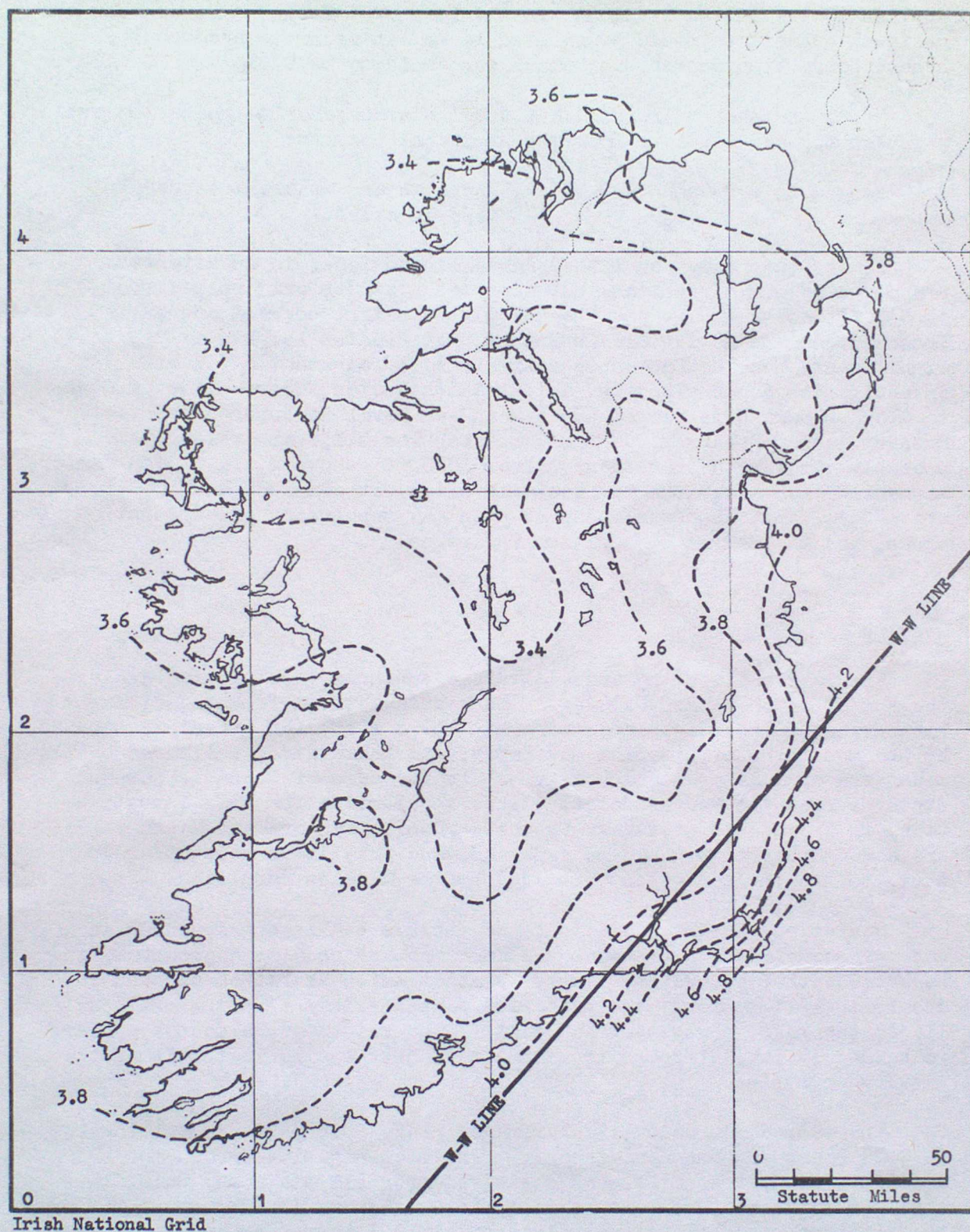


FIG.1 - Average means of daily duration of Bright Sunshine, 1921-50. (hours).

(4)

Cw was evolved for coastal stations, using the means of Mw and BV - S, where BV is the base value and S the true or actual average sunshine. Cw was found to be 0.047 per 10 miles. This correction factor was then applied to the inland stations, in the form BV - Mw(Cw) - S, so that the residual quantities could be related to Mc, in order to produce the second correction factor, Cc, which was found to be 0.058 per 10 miles.

Using the base value of 4.13, a calculated sunshine value (Sc) was produced for all stations from the empirical formula:

$$Sc = 4.13 - 0.058Mc - 0.047Mw, \text{ where } Mc \text{ and } Mw \text{ are measured in tens of miles.}$$

Sc was then compared with S for hill stations, in an attempt to produce a height correction, but elevated stations only ranged from 205 to 534 ft. above M.S.L. and the calculated height correction was inconsistent and negligible in amount; at greater heights it may be significant, but the factor is unlikely to be constant. In his investigation for England and Wales, Smith quotes a correction of 0.04 to 0.05H, where H is height above mean sea level in hundreds of feet. However, this appears to be too large for low hills in Ireland, and probably applies to elevations nearer 1000 ft. above m.s.l. The factor may well reach a maximum for mountain sites between 2000 and 4000 ft. above m.s.l. but much would depend upon the topography of adjacent areas, and the degree of maritime influence.

Results

Figure 2 depicts the annual average sunshine (S), plotted against the sum of 0.058 Mc and 0.047Mw. Marked deviations from the straight line grouping include Shannon airport, where a shelter effect is provided by the mountains of Limerick and Kerry, and Malin Head, sheltered by the mountains of Inishowen and Donegal. In the case of Shannon, however, distance from the nearest coast (taken as 25 miles for this investigation) is a somewhat arbitrary figure. Dublin airport and Howth values are also higher than would be expected, and this is no doubt due, in part, to the shelter effect provided by the Wicklow mountains.

Deviations in the opposite sense include Ballinacurra, which is very exposed to the south-west via Cork harbour and its approaches, and Markree Castle, Co. Sligo, another station which is rather exposed in the south-west sector; the main hill masses within a radius of 20 miles lie to the west, north-east and east. The value for Baldonnel appears to be unduly low, although the station is just by the foothills of the Wicklow mountains.

The errors for calculated averages range from 0.02 for Mullingar, to 0.25 hours for Shannon airport. The mean negative error (10 stations) is 0.12 and the mean positive error (12 stations) 0.10; thus a slight adjustment of base value to 4.14 balances the errors. 55% of the stations give calculated values within 0.1 hours/day of the correct average value, and with the exception of Shannon the error is less than 0.22 hours/day for all stations.

Conclusions

The average annual sunshine in hours per day for any lowland place in Ireland (excluding Co. Wexford) will be given to a reasonable degree

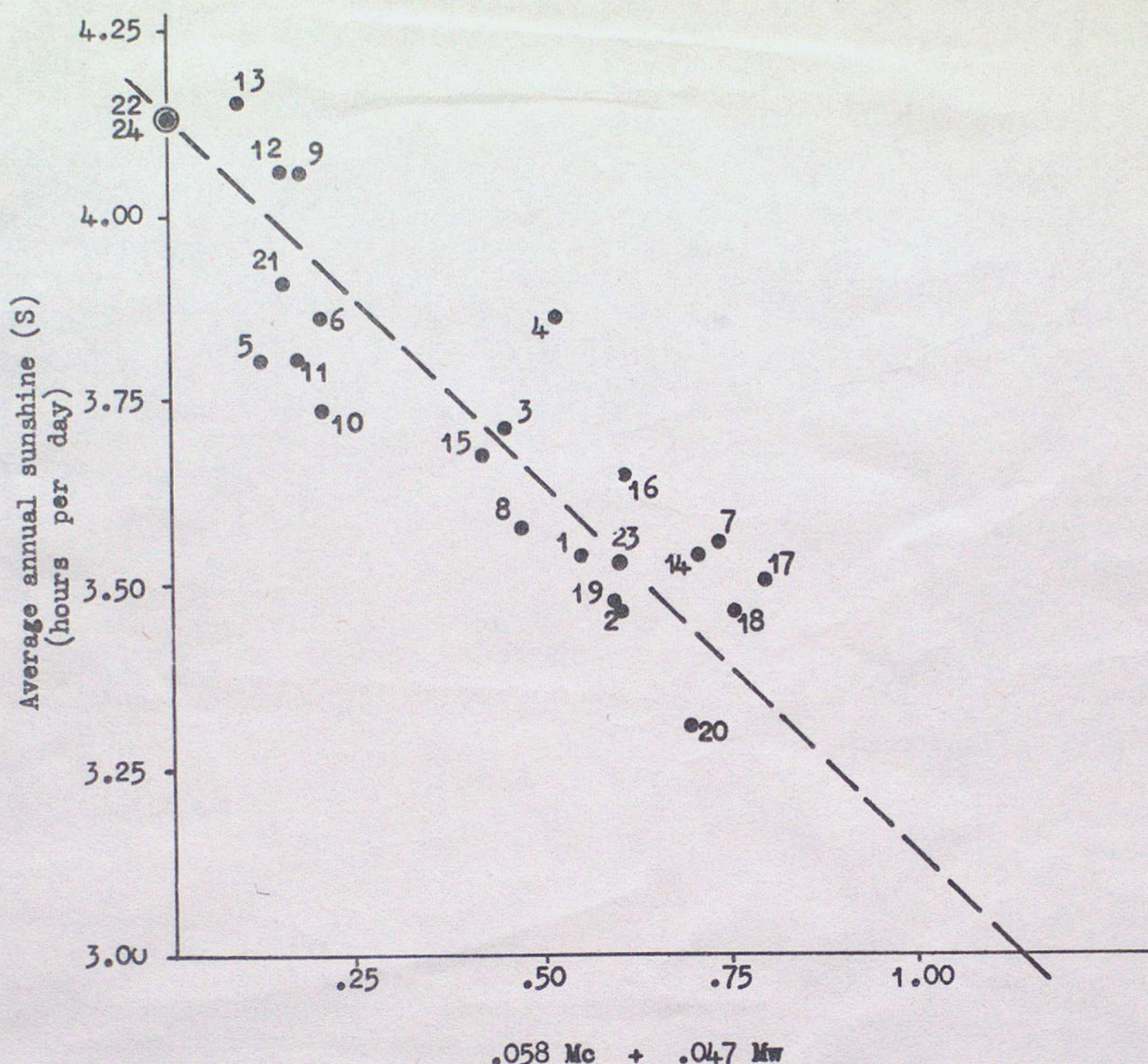


FIG.2 - Annual average of bright sunshine (S) plotted against the sum of $.058Mc$ and $.047Mw$ for stations listed in Table 1.

of accuracy by the formula:

$$4.14 - 0.058Mc - 0.047Mw$$

where Mc is distance from the nearest coast, measured in tens of miles, and Mw is distance from the Wicklow-Waterford line, or its extension, measured in tens of miles.

The records for Wexford suggest approximate average sunshine values (daily mean) ranging from 4.1 hours in the north-west, to 4.8 hours in the south-east of the county.

The sheltering effect on places situated downwind of significant hill masses may result in actual sunshine averages which are 5-7% in excess of calculated values.

Acknowledgement

I would like to acknowledge the assistance given by the Director of the Meteorological Service, Dublin, in providing sunshine data for stations in the Republic of Ireland.

Reference

- ¹ Smith, L.P.; Average sunshine, distance from coast and height above sea level. Nat.Agric.Advisory Serv. Q.R. Vol.XI, Summer 1960.